A Guide to Growing

BANANAS

in the Eastern African Highlands

A Guide to Growing Bananas in the Eastern African Highlands

by

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International Centre of Insect Physiology and Ecology (ICIPE)

July 1998

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ISBN: 92 9064 120 7

Published by
ICIPE Science Press
PO Box 72913
NAIROBI, Kenya
Tel: +254-2-861680–4
Fax: +254-2-860110/803360
Email: icipe@africaonline.co.ke or isp@icipe.org

Foreword

This *Guide to Growing Bananas in the Eastern African Highlands* provides basic as well as technical information on planting bananas; general maintenance of established banana fields; management of banana pests and diseases; and care and harvesting of banana bunches. The Guide is dedicated to banana growers, extension officers, agricultural associates and anyone else involved and interested in the production of bananas and plantains.

The Guide is of special interest for growers in the Eastern African highlands, a region of perpetual food shortage, in which bananas are an important cash crop and staple food which can be cultivated for local consumption or for regional and global export. For these farmers, this Guide will be a helpful tool for sound banana production for improving food security and income generation. The Guide encourages the use of an integrated pest management (IPM) approach as a viable alternative to the use of environmentally toxic pesticides.

This publication derives from a joint project between the International Centre of Insect Physiology and Ecology (ICIPE), the University of Bonn and the Agricultural Research Institute in Tanzania. We are grateful for the financial support from the Federal Ministry of Cooperation and Development (BMZ) of Germany through the Germany Agency for Technical Cooperation (GTZ). We would like to thank Annalee Ng'eny-Mengech for providing us with her encouragement and useful suggestions, to Kathy Overholt for the editing and to Newton Mwanga Komeri for the illustrations.

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Introduction

Bananas and plantains are some of the most important food crops in the world. Grown principally in developing tropical countries, the total annual production of bananas and plantains is 85.5 million tonnes. There are two main types of bananas—dessert bananas and cooking bananas. While dessert bananas are exported to Europe, the United States and Japan (9 million tonnes annually), cooking bananas are an important carbohydrate source in developing countries.

Bananas are the largest herbaceous plant. The fruit is a rich source of carbohydrate (35%), fibre (7%), minerals (potassium, magnesium, phosphorous, calcium and iron) and vitamins (A and C) (Table 1). While dessert bananas are consumed directly after ripening, cooking bananas are boiled, roasted, fried, steamed, baked, brewed or dried and ground into flour (Table 2). Dried banana plant sheaths are woven and used for thatching, making ropes, cots, bandages, hats, ornaments and as shading. The pseudostem fibre is used for fishing nets, cattle feed and mulch.

Table 1. Mineral content of banana leaves[1]

Macronutrients	
Nitrogen*	2.6–4.0%
Phosphorus*	0.19–0.25%
Potassium*	2.6–3.0%
Calcium	0.75–1.25%
Magnesium	0.3–0.46%

[1] Values represent normal range of minerals by dry weight.
*Major nutrients

In 1988, bananas were ranked the third most important carbohydrate staple in the world after cassava and sweet potato. In Africa, 24.6 million tonnes of bananas are produced annually, making them the third most valuable crop after cassava and maize. In East Africa, bananas are a staple food for more than 20 million people. The average annual

consumption per person in the East African highlands near the Lake Victoria basin is 250–350 kg. In Europe, the annual consumption of dessert bananas per person is 11 kg

Table 2. East African Highland banana cultivars and their use

Cultivar group	Cultivars	Areas of common occurrence	Use
Mboko	Mboko Ibwi Muhoye Ntebwa	Usambara Mountains, Tanzania	Cooking
Mshare	Nshonoa Mnanambo Mlalembo	Kilimanjaro & Meru Mt areas	
Matoke	Nakyatengu Mbwairuma Nshakara	Lake Victoria basin, highlands	
Cavendish	Kiguruwe Robusta Paz	Coastal, lowland areas	
Plantain	Mkono wa tembo Mzuzu	Coastal, lowland areas	Roasting
Mbire	Nshanshambire Ntalibwambuzi Enyamawa	Lake Victoria basin, highlands	Brewing
Kisubi	Kisubi or Kijivu	All banana areas	
Kijoge	Gros Michel or Bogoya	Lake Victoria basin, highlands	Dessert
Kisukan	–	All banana areas	
Bluggoe	Bokoboko Ngazija	Coastal, lowland areas	Multi-purpose

Originally, there were two wild species of banana plants, *Musa acuminata* and *M. balbisiana*. With time, these two species hybridised to generate the numerous cultivars available today. The genetic *acuminata*-types of bananas (AA) originated in Malaysia and hybridisation between sub-species gave rise to a range of diploid (AA) and triploid (AAA) cultivars. The *balbisiana*-types (BB) originated in the Indian sub-continent. The spread of AA-types through Southeast Asia to the Indian sub-continent led to hybridisation between AA and BB types which gave rise to the AAB and ABB cultivars that are grown worldwide today.

Bananas with the AA or AAA genomes are typically sweet and cultivated as dessert banana. Hybrids with AAB (plantain) and ABB genomes are starchier and therefore used as cooking bananas. AAB and ABB hybrids are grown in coastal lowlands, while the AAA-type grow well at elevations of 1000–1800 metres. It is the AAA-varieties that are widely grown in the East African highlands.

These highlands are a system of high plateau, mountains, valleys and lakes which extend across Ethiopia, Eritrea, Burundi, Kenya, Rwanda, Tanzania, Uganda and the Democratic Republic of Congo. This region of high elevation receives intermittent heavy rainfall and high winds and is often sloping land. The total annual production of banana and plantain in this region is 13.2 million tonnes, about 20% of the global production.

Bananas in the Lake Victoria basin are an important source of food and income for local smallscale subsistence farmers. While this manual is a general guide to growing bananas, the focus is on banana cultivation in the East African highlands.

The Banana Plant

A banana plant is composed of the corm (rhizome or bulb), pseudostem, leaves, bunch and roots (Fig. 1). The plant reproduces asexually from suckers which arise spontaneously from the corm. The primary banana plant and the budding suckers constitute the banana mat or stool (Fig. 2).

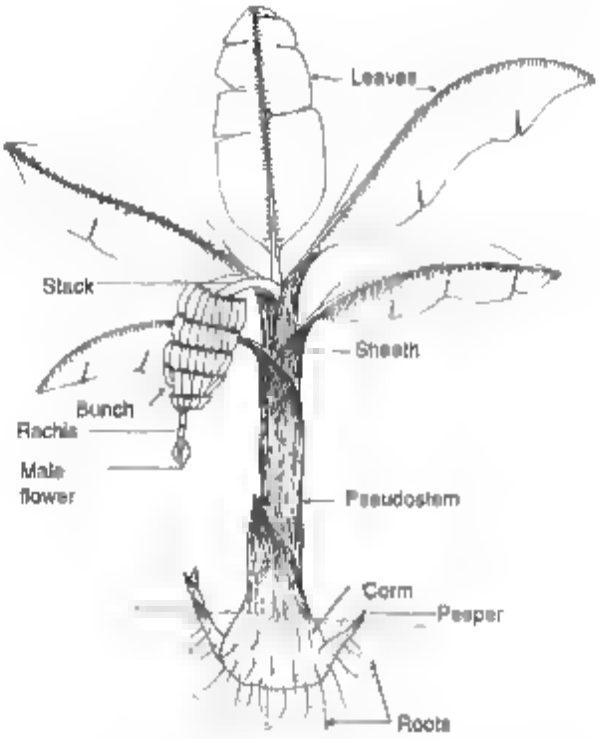


Fig. 1. Parts of a banana plant

Corm

The corm is the underground basal part of the plant. In longitudinal section, it is composed of the cortex, central cylinder and shoot buds. The central cylinder acts as a food reservoir for a growing plant.

Roots

Banana roots are adventitious and arise from the corm. They are extensive and found in the upper 60 cm of the soil. Depending upon the soil condition, they may grow in a lateral direction in excess of

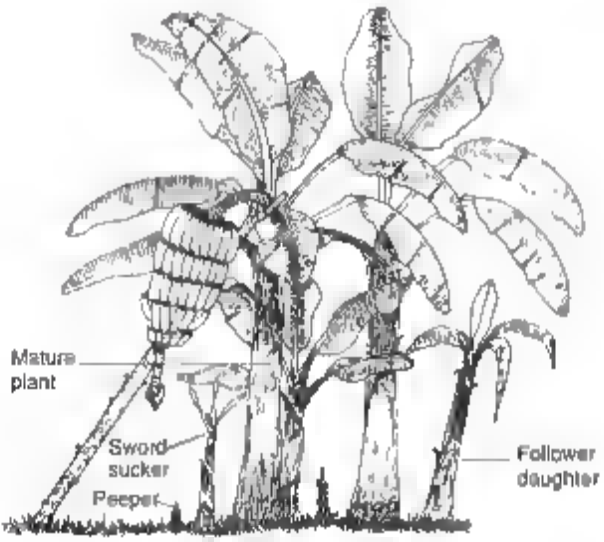


Fig 2 Banana stool (mat) with banana in different stages of growth

1 5 metres. Roots anchor the plant and provide water and mineral nutrients One corm may have 400–700 roots

Pseudostem

The ascending portion of the plant (stalk) grows from the top of the corm. It supports the aerial stem which terminates in the bunch The pseudostem is comprised of crescentic (C-shaped) leaf sheaths.

Leaves

The tips of the leaf sheaths give rise to leaves which perform photosynthesis. Leaves are comprised of the petiole, which is continuous with the midrib, and lamina of the leaf sheaths. Leaf production ceases after shooting. A normal plant maintains an average of 14 photosynthetically active leaves at any time before shooting. Throughout its life, a pseudostem produces an average of 65 leaves

Inflorescence

Inflorescence (shooting or flowering) occurs when the aerial stem pushes through the pseudostem. Due to gravity, the inflorescence that begins in vertical growth is turned downwards The inflorescence is

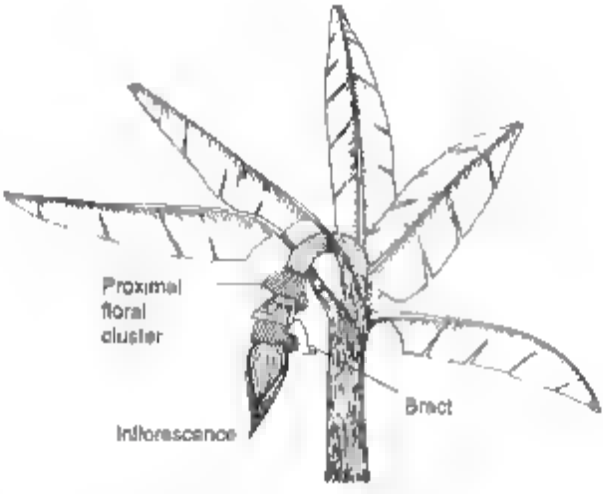


Fig 3 The banana inflorescence

composed of proximal floral clusters with developed ovaries, styles and stigmas which develop into the banana bunch (Fig 3). The male bud is formed from degenerated stamens and distal clusters Each floral cluster is punctuated by a bract, which is shed as the bunch matures As the male bud grows, mature flowers are shed, and at maturity, a small male bud is apparent at the tail-end of the floral axis (See Fig. 1) The process of inflorescence formation is unique among different banana varieties.

Bunch

The bunch is formed at the apex of the aerial stem and consists of a cluster (hand) of 10–16 individual fruits called *fingers*. The taste, size and shape of the finger and its colour before and at maturity, as well as the shape of the bunch, are specific characteristics that distinguish different banana varieties Edible bananas do not have seeds and flowering occurs without pollination (parthenocarpy) (Fig 4)

Banana plant growth cycle

There are four distinct phases of growth of a banana plant. In the first stage, the plant grows vegetatively and produces its maximum number of leaves. This stage lasts approximately 11 months for the majority of cultivars. In stage two, inflorescence occurs, which takes about one month This is followed by bunch

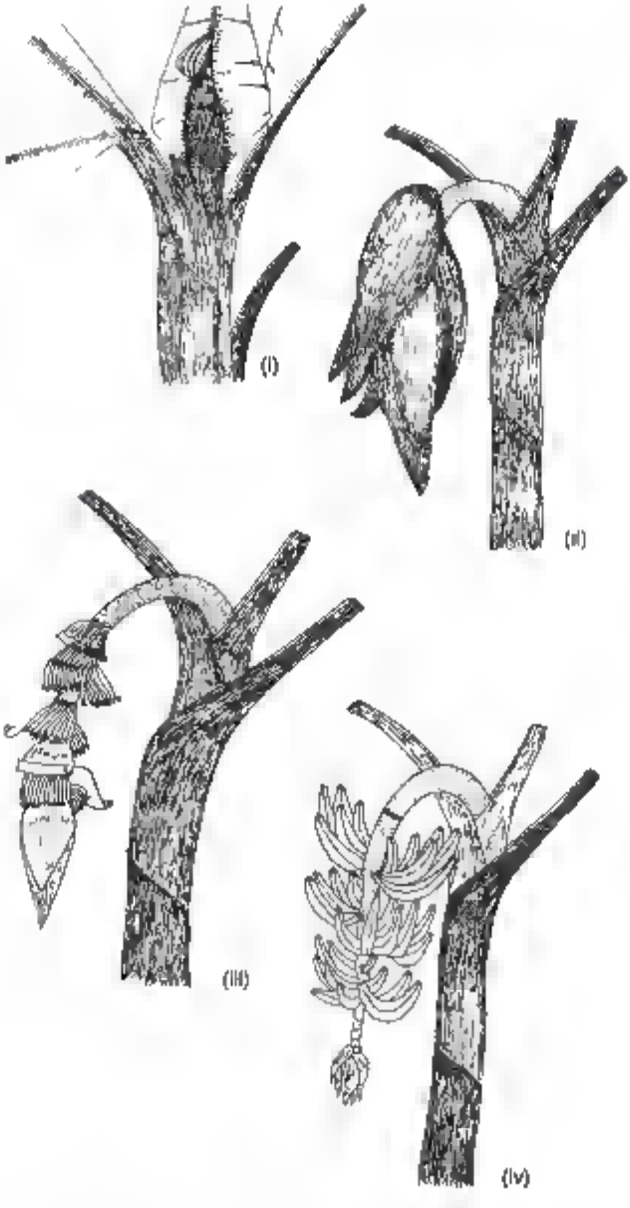


Fig. 4. Development stages of a banana bunch

development, which lasts approximately six months The final, and often unnoticed, phase is senescence which takes about two months. During this phase, the plant degenerates and the leaves and roots die; however, the pseudostem remains and serves as a source of water and nutrition for the developing peeper (second generation plant) (see Fig 2)

Planting and Management of Bananas

Environmental requirements

Bananas grow at altitudes ranging from 0 to 1800 metres above sea level. Rainfall of at least 1000 mm per year is necessary and ideally should be equally distributed throughout the year. The optimal temperature to grow bananas is 28°C. Below 16°C and above 38°C, growth is hindered. The plants require sunlight, and shaded areas should be avoided. Plants should be grown on sites that are sheltered from the wind as bunch-bearing plants topple easily. Banana plants require deep, fertile and well-drained soils. Water-logged soils as well as acutely acidic and saline soils should be avoided. Light soils with minimal pebbles and a pH of 5–6.5 are ideal. The soil should be fertile and contain organic matter as well as nitrogen, potassium and magnesium.

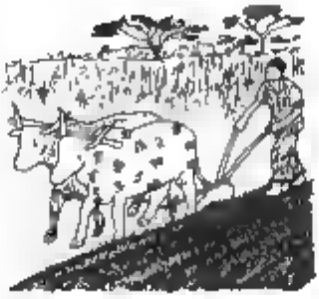
Planting site

Banana plants should be planted on land that does not have a history of poor banana crops or land left fallow for at least one year. The ground should have a gentle slope. Steep slopes, rocky areas and water-logged sites should be avoided. Choose fields with fertile, deep and well-drained soil. In windy sites, agroforestry and fruit trees should be used as windbreaks to reduce plant breakage.

Field preparation

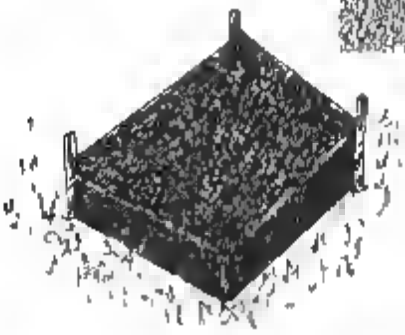
The bush should be cleared and the debris removed from the field and composted. Compost serves as an excellent source of organic manure for banana plants. After the land is cleared, the fields are ploughed and harrowed. This can be done with a tractor fitted with appropriate implements or by hand with a hoe. Since banana roots are soft, a tilth depth of 60 cm is desirable. The field should be prepared in the dry season (Fig. 5).

Hand digging

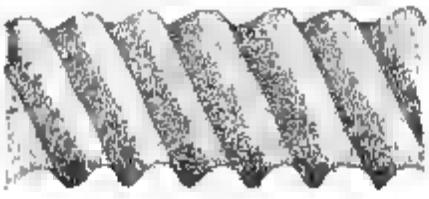


Oxen ploughed

Tractor ploughed



Compost manure preparation



Ploughed land

Fig. 5. Field preparation

Field layout

The recommended inter-row and inter-plant distance depends upon the cultivar being planted. Banana varieties are grouped according to size into four categories: small (dwarf Cavendish), medium (Nakyetengu and Nshakara), large (Gros Michel) and extra-large (red sweet or mzungu mwekundu). The ideal inter-row and inter-plant distances in metres for the various varieties are:

small:	2.5 by 2 5, or 1600 plants per ha;
medium:	3.0 by 3.0, or 1110 plants per ha,
large:	3.5 by 3 5, or 816 plants per ha; or
extra large:	4.0 by 4 0, or 625 plants per ha.

Hole preparation

In level fields, planting-holes should be dug in rows along straight lines On undulating sloping land, planting-holes should be dug along the contours. The planting-holes should be 90 cm in diameter and 60 cm deep. In dry areas, holes 120 cm wide are preferable. When digging the 60-cm-deep hole, soil from the top 30 cm should be heaped on one side of the hole (top soil) and soil from the remaining 30 cm shoutd be heaped on the other side of the hole to be discarded. The top soil should be mixed with organic manure and returned to the hole in preparation for planting (Fig 6).

Soil preparation

The best manure to use is farmyard manure from cattle, pigs, goats and chickens. Compost or coffee husk humus can be used Seventy kilograms (70 kg) or 5 debes (20 litres/debe) of dry or organic manure should be thoroughly mixed with the top soil The bottom soil is scattered elsewhere in the held. Diammonium phosphate (200 grams) can also be added at this stage to the manure/top soil mixture to enhance soil fertility and promote root formation. The top soil manure/fertiliser is then returned to the planting hole. If the mixture does not completely fill the hole, top soil from the surrounding areas should be added. The centre of the hole should be marked with a peg and then left undisturbed for a minimum of two weeks

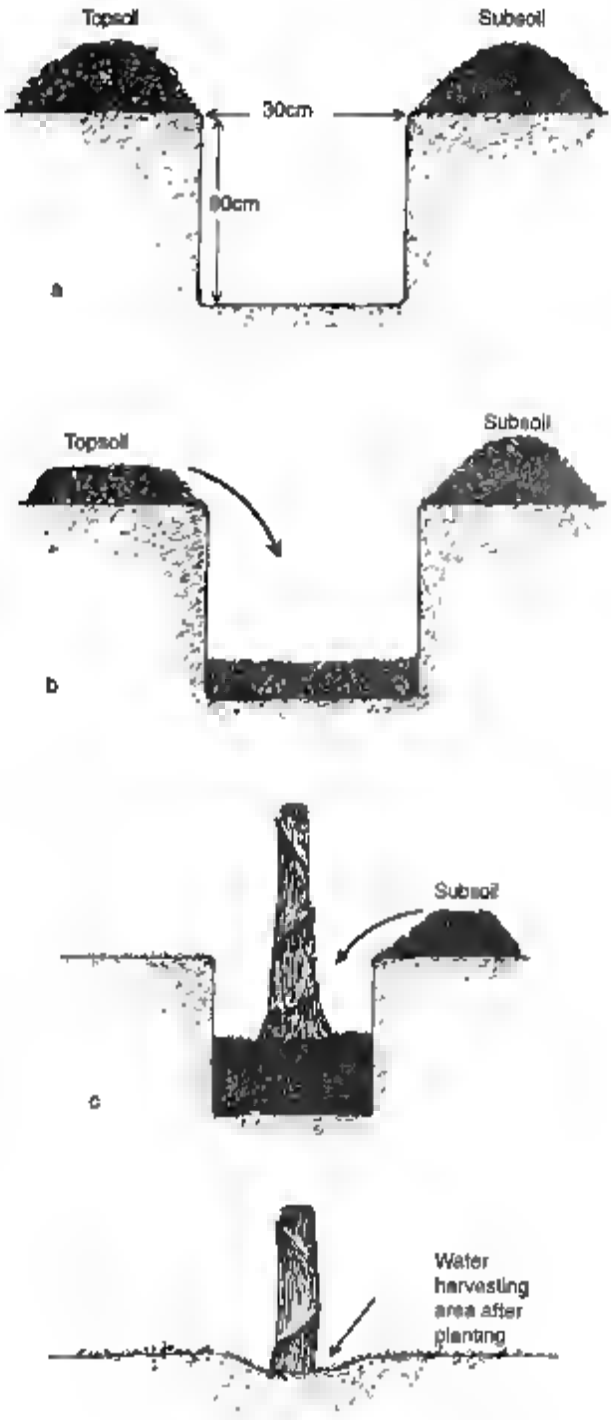


Fig 6. Preparation of banana planting holes and planting

Cultivar selection

A number of different cultivars are available, and the variety selected depends upon environmental conditions and desired end-use. Banana cultivars respond differently to weevil and nematode attack. The sweet (dessert) types are generally more tolerant, followed by cooking types, beer varieties and the roasting types.

Planting materials

Plant materials for transplanting are obtained from an established mat, multiplication plot or tissue culture laboratory. From an established mat, there are four different sources of planting materials:

- Sword suckers: These are the best transplanting materials (see Fig 2). Suckers approximately 1–1.5 m tall are carefully uprooted from a mat. The leaves (including the unfurled leaf) and the roots may be cut off, especially when the weather is dry, and a thin layer of the corm is peeled off (paring) at the collection site to minimise the spread of pests.
- Corm splits: On the corm of sword or maiden suckers, eyes (shoot buds) are visible. To plant corm splits, the pseudostem is removed from the suckers, the corm is excavated and then cut into longitudinal slices, each of which should bear one or more eyes (Fig. 7).

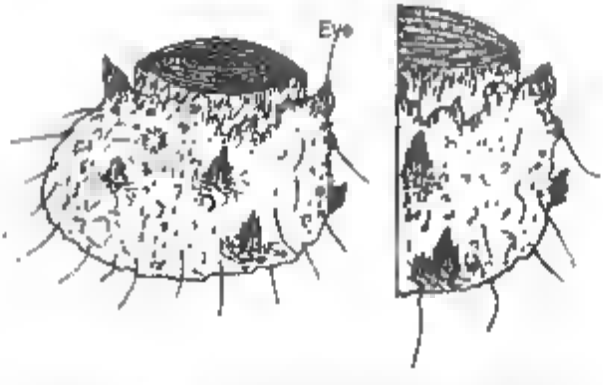


Fig 7. Banana corm split to generate more planting material

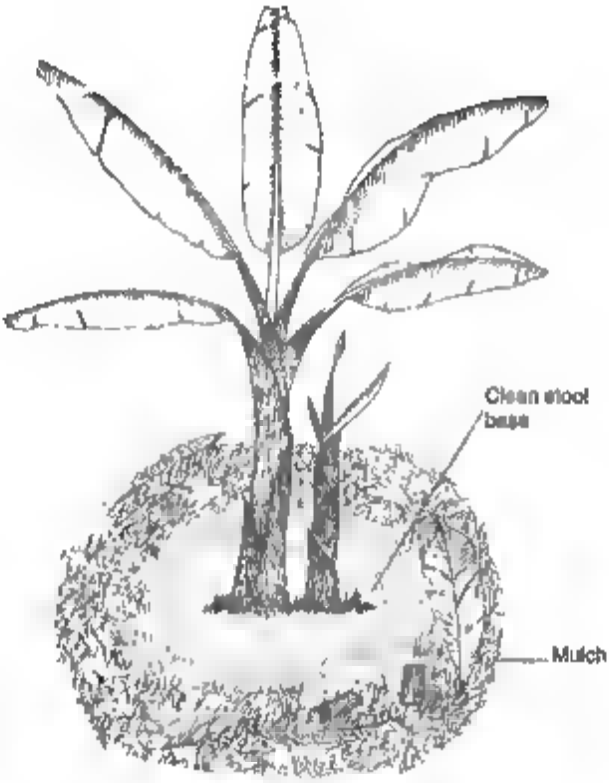


Fig. 8. Mulching technique in banana field

- Bull head: In the absence of sword suckers and corm splits, a harvested plant can be used as a plant source. The harvested plant is trimmed to a height of 1–1.5 m from the pared corm before it is planted.
- In unusual situations, peepers (see Fig. 2) and water suckers can be planted in a manner similar to sword suckers. However, water suckers, which are broad-leaved and non-vigorous, are weak and their use as transplanting materials should be avoided.

Planting

Banana crops should be planted at the beginning or during the long rainy season. In the prepared planting-hole, a central hole 30 cm in diameter and 60 cm deep is made.

- A treated sucker or bull head is inserted vertically into the hole and covered with soil

Project Activities

Plate 1 Banana market in the East African Highlands

Plate 2 One of the IPM field trials on an AAA EA (Nakyetengu) cultivar in progress at Oyugis in western Kenya

Plate 3 Mobile training course on banana IPM for farmers at Ungoye on the shores of Lake Victoria

Plate 4 Roots of toppled plants damaged by nematodes showing extensive lesions

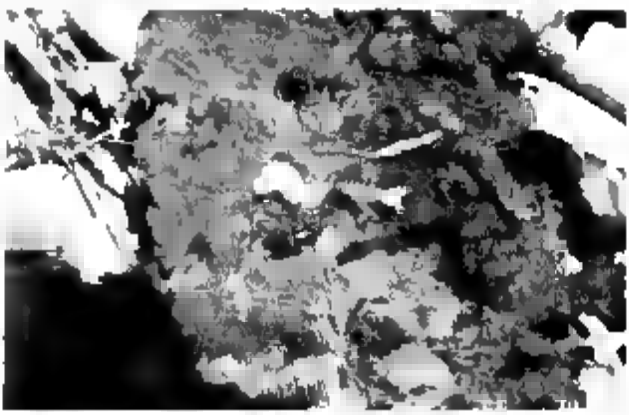


Plate 5. Banana weevil grub and adults

Plate 6 Rhizome showing weevil damage

Plate 7. Plant showing symptoms of Black Sigatoka disease

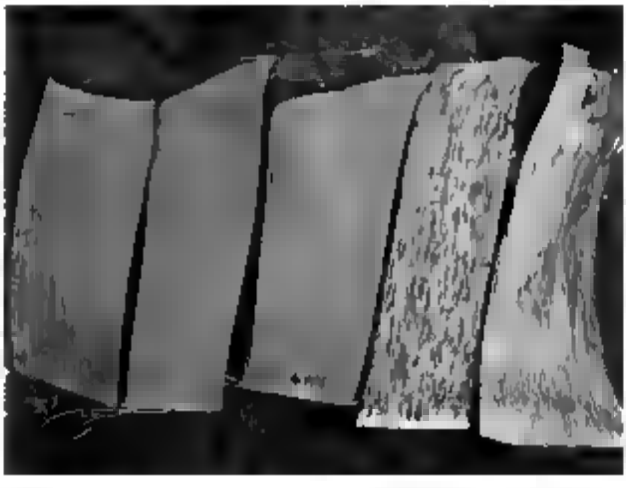


Plate 8. Black Sigatoka progressive leaf damage

Plate 9. Banana affected by *Fusarium* wilt

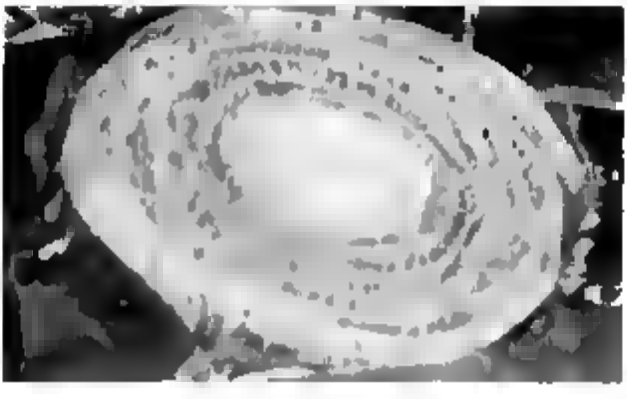


Plate 10. Cross section of a pseudostem affected by *Fusarium* wilt

(see Fig 6). To support the sucker, the soil around the pseudostem is compacted by foot.

- When using corm splits the split is placed horizontally in the bottom of the hole with the eye facing down. It is then covered loosely with soil.

Deep planting reduces weevil infestation and delays high mat development and toppling. A small furrow around the planted sucker will serve in water harvesting.

Mulching

Mulching conserves moisture, controls weeds, contributes to soil fertility and reduces soil erosion. After the crop is planted, a 15-cm layer of mulch should be applied on the field. Mulch can be grass, chopped banana leaves and pseudostems or intercrop remains like groundnuts and beans. The mulch should be kept away from the base of the plants to prevent superficial root growth. It should be spread evenly to reduce incidence of the banana weevil (Fig. 8 on page 20).

General Maintenance of an Established Field

Weeding

Bananas need clean weed-free fields for optimal growth. While mulching will significantly minimise weed problems, individual weeds that arise can be uprooted either by hand or with a small hoe (kafuka kabandama) (Fig. 9, Table 3). Banana roots are shallow and manual weeding should be done carefully without damaging the plant's root system. Weeding should be done regularly and at least twice during each rainy season. Weeds such as *Commelina bengalensis, Digitaria scalarum, Bidens pilosa, Solanum nigrum* and *Cynodon* species have been found to be alternate hosts to banana nematodes, so clean weeding discourages banana nematode build-up. Spot application of herbicides such as Round-up, Gesapax, Gesaprim and Gramaxone may be used with no soil disturbance; however, costly chemical intervention should only be used as a last resort

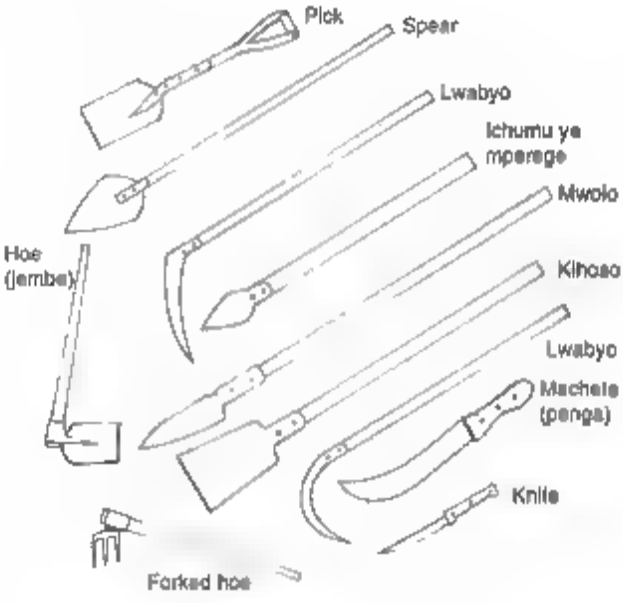


Fig 9 Useful tools in the management of banana farms

Table 3. Tools for banana field care

Tool	Description and use
Forked hoe	Desuckering and cultivating the land into fine tilth
Pick	Planting and incorporating manure into soil
Machale (pange)	Harvesting banana and paring
Lwabyo	Detrashing high leaves
Mwolo	Detrashing and removing dried leaf sheaths
Ichumu ya mparega	A small spear for planting beans into banana field, ensures little damage to banana leaves
Kihoso	Thinning bananas into standard stools, bearer, follower and peepar
Kafuka kabandeme (small hoe or kajembe)	Spot weeding in banana fields
Hoe (big)	Weeding and planting hole preparation
Spade	Preparation of planting-holes (along with the hoes)
Spear	Desuckering tool

Fertiliser

The bunches and leaves that are continually being removed from the plant represent a significant and continuous loss of nutrients from the field. To maintain soil fertility, three debes of farmyard manure mixed with 250 grams of mixed fertiliser (NPK) should be incorporated annually into the soil around the banana stool. Grades such as 16-8-24 or 15-7-21 are desirable, or any other mixed fertiliser available in the local market can be used.

Nutrient monitoring

Plant girths in each stool may give indication of soil fertility. A year after planting, the follower (daughter) pseudostem should be larger in diameter than the main (mother) stem, this indicates adequate soil fertility. However, when the girths of the mother and daughter pseudostems are similar, soil fertility is on the decline. When the daughter pseudostem is smaller in diameter than the mother, there is an acute shortage of soil nutrients. The optimal time to apply

fertiliser is when the girth of the daughter pseudostem is equal to that of the mother.

Desuckering (thinning)

Banana plants are proliferous and a single corm can produce more than 10 suckers annually. Ideally, there should be three plants at varying stages of development, growing on each mat or stool: a mother or bearer with a bunch; a daughter that is half the size of the mother, and a peeper or granddaughter, which is a newly emerged sucker (see Fig. 2). Any other unwanted suckers deplete the mat of the vital nutrients, provide unnecessary shade and need to be continuously removed. This process will increase the quantity and quality of the bunches. The excess suckers can be continuously removed with a hoe and spear (Fig. 10). The unwanted suckers can be used as mulch or as planting materials.

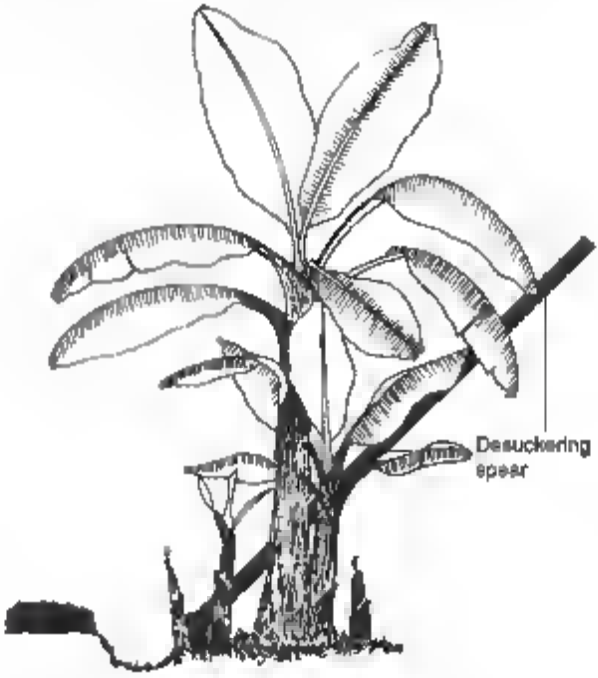


Fig. 10. Desuckering of the excess suckers

Detrashing (deleafing)

Detrashing is the removal of dead or dried leaves from the plant. These leaves can then be used as mulch.

Propping and guying

Plants with heavy fruit bunches are prone to breakage (especially when there are strong gusting winds) and can be propped up and supported with bamboo poles and rope. Weakly anchored or nematode/weevil infested plants are susceptible to toppling, and snap even with slight wind (Fig. 11).

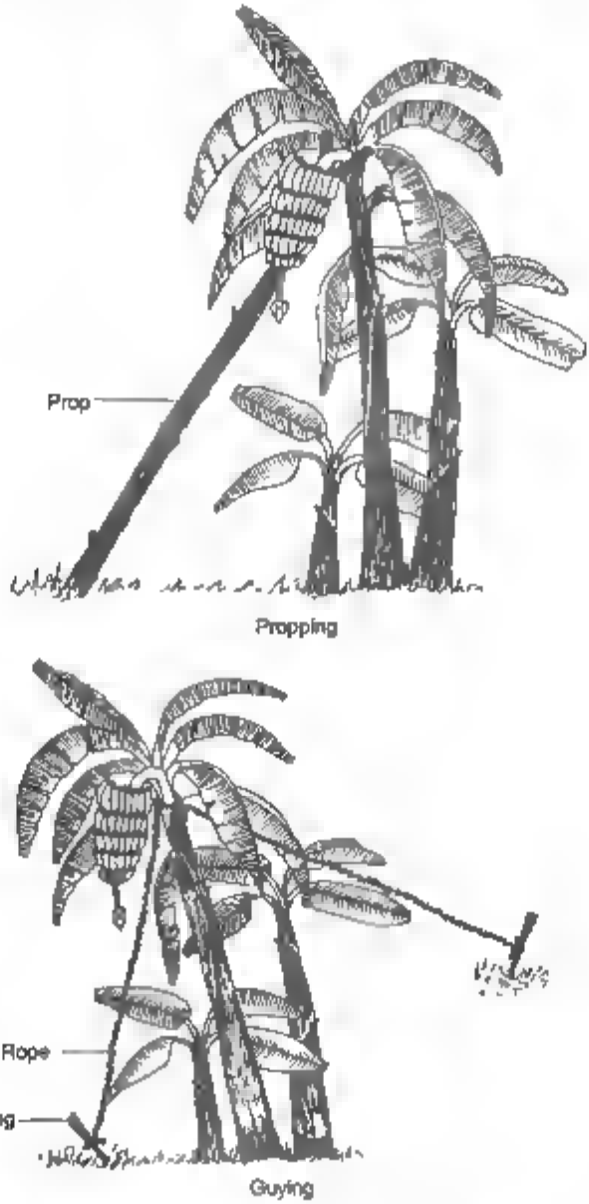


Fig 11. Wind blow-down to bearing banana is minimised by using props and guys (ropes)

Water conservation

Banana is a succulent crop which requires a lot of water and is susceptible to drought. In ecological zones which receive less than 1000 mm of rainfall annually, water conservation practices should be employed. Irrigation is the commonest though most expensive method of providing continuous water to crops. However, conserving rainwater may be a more practical method for smaller land-users. There are two recommended methods:

- Heavy mulching: a 15-cm layer of mulch regularly applied to the field minimises evaporation and water run-off.
- Trench-manuring: trenches 2 m long, 60 cm wide and 90 cm deep are dug midway between the stools along the row. The bottom 45 cm of the holes are filled with farm manure and topped up with top soil. During the rainy season, manure absorbs and stores water which the plants utilise during the dry season. An alternative to manure is freshly cut banana pseudostem.

Banana Pests and Their Management

Plant pests result in crop losses and decreases in bunch weight and quality. Since bananas are perennial, crop rotation is difficult to practice for pest control. In the East African highlands, the most important pests attacking banana crops are banana weevils and nematodes. Frequently, these two pests will simultaneously attack the plant and the symptoms of damage will be additive for each pest.

Other less common highland insect pests include banana aphid *(Pentalonia nigronervosa)*, red rust thrips *(Chaetanaphothrips orchid)* and peel scarring beetle *(Colaspis ostmasrki)*.

Banana weevil *(Cosmopolites sordidus)*

Adult weevils are initially brown but turn black a few days after emergence. Female adults lay their eggs in scars they make at the base of the banana plant. A gravid female can lay up to 200 eggs during its lifetime (not exceeding two years). Eggs hatch and become larvae after a 6–8 day incubation period. The first tiny instars are white with brown heads. They feed and eat their way into the corms and pseudostems and make tunnels which characterise their damage. After growing and tunnelling for 14–21 days, the larvae pupate. Fourteen days later, they hatch into adult weevils. The adults feed on rotting plant debris (Fig. 12).

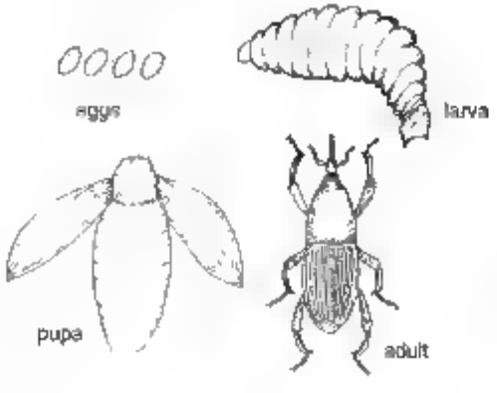


Fig. 12 Developmental stages of the banana weevil

The symptoms of banana weevil infestation include:

- tunnelling in the corm and pseudostem
- pseudostem snaps at ground level
- yellow leaves on stunted plants with weak stems.

Nematodes

There are four major species of nematodes that infest banana varieties in the highlands:

- *Pratylenchus goodeyi*—lesion nematode
- *Radopholus similis*—burrowing nematode
- *Helicotylenchus multicinctus*—spiral nematode
- *Meloidogyne incognita*—root-knot nematode.

The adults are tiny worms—less than 1 mm long—invisible to the naked eye; they feed on the root and corm. Eggs are laid and the immature stages develop in these tissues. In the tropics, the life cycle takes approximately 30 days. Symptoms of nematode infestation include:

- extensive primary and secondary root necrosis
- cortical tissue exhibits red bordered lesions which extend to the stele (*P. goodeyi* and *R. similis*)
- gall production on primary roots (*M. incognita*)
- plant toppling

Dispersal of banana weevils and nematodes

These pests are primarily dispersed by transplanting infested suckers and corms. While neither weevils nor nematodes can fly, they are slowly motile. Weevils are able to move on ground and nematodes in soil from one infested field to the next.

Management of weevils and nematodes

Break cropping

In fields infested with weevils and nematodes, growing non-host plants such as sweet potato (*Ipomea batatas*) instead of bananas for at least 1.5–2 years will naturally clear the pest from the area. After this period, bananas may again be planted.

Intercropping
Mixing banana crops in the same field with other crops such as legumes, minimises weevil movement. Intercropping also serves to prevent soil erosion and to restore soil fertility. In Bukoba, Tanzania and in Kisii, Kenya, beans and groundnuts, respectively, are good intercrops. Avoid intercropping with crops such as sweet potato which compete with banana for nutrients.

Cleaning of planting materials
Nematodes and weevils are located mainly in the roots and corms of banana plants. To significantly reduce the incidence of transferring pests from one infected site to another when transplanting suckers, care should be taken to:

- remove the roots
- pare the corm to a depth of 0.5 cm (Fig. 13)
- cut off all lesions and weevil tunnels

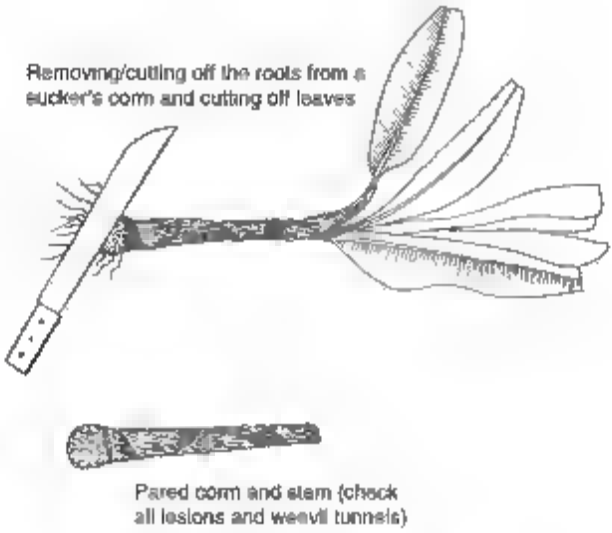


Fig. 13. Paring of planting material

In addition, the pared suckers and corms may be:

- immersed in hot water (54°C) for 20 minutes
- sterilised in a solarium at 54°C for 20 minutes
- dipped in an appropriate insecticide/ nematicide solution for 24 hours

A home-made thermometer for hot water treatment can be assembled from candle wax, a metal piece and pith. Molten candle wax is used to join the metal and pith into one unit. The assembly is immersed in cold water and will sink to the bottom. The water is then heated and on attaining 55°C (critical melting point of candle wax), the wax will melt and the pith floats, leaving the metal piece at the bottom. Heating is stopped and the pared suckers are immersed in the hot water for 20 minutes (Fig. 14)

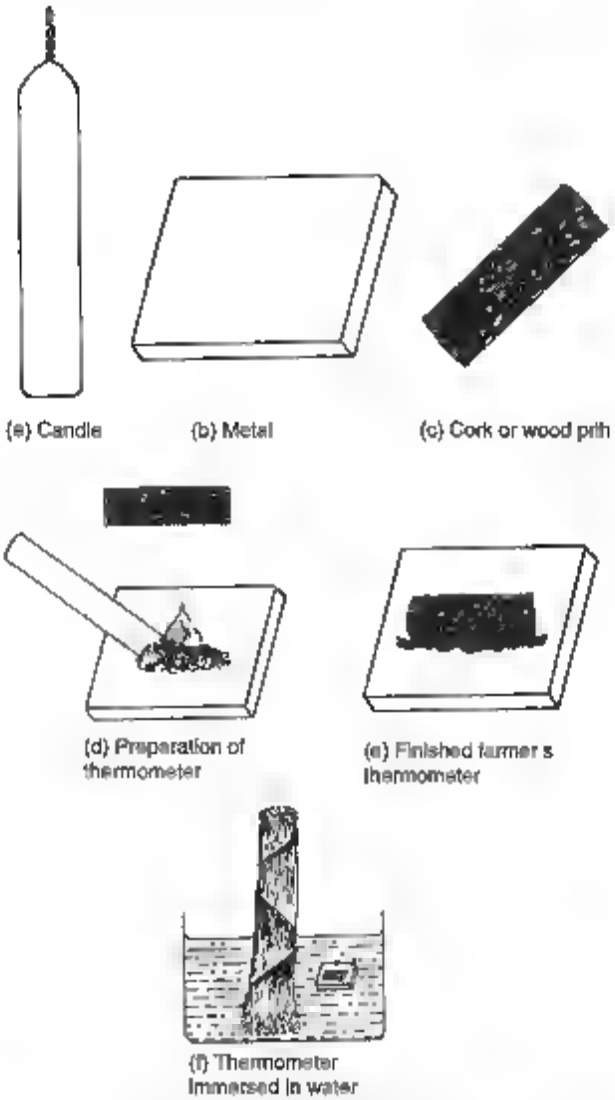


Fig 14 Cleaning planting material through hot water treatment and preparation of a farmer's thermometer

Resistant cultivars
There are a number of varieties of banana plants that are genetically resistant or tolerant to weevil or nematode damage that may be planted.

Deep planting
Weevils prefer to lay eggs on the corm at ground level. To discourage weevil egg-laying, the corm should be planted at least 60 cm deep so that only the leaf sheath of the suckers are at ground level. This also reduces and delays the incidence of high mat formation.

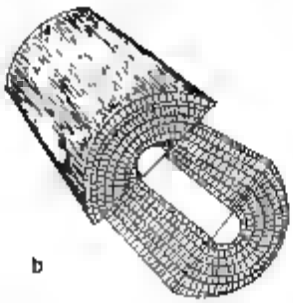
Weevil trapping
While adult weevils do not themselves damage the banana plants, over a 2-year period, a single adult female can lay up to 200 larvae-hatching eggs per year, causing serious damage. Adult weevils are strongly attracted to freshly cut pseudostems and corms. These plant materials are therefore ideal for trapping adult weevils. The trapping technique may be used continuously in the field. Three types of traps are commonly used:

- split pseudostem pieces
- disk on stump or ground
- leaf covering on corm.

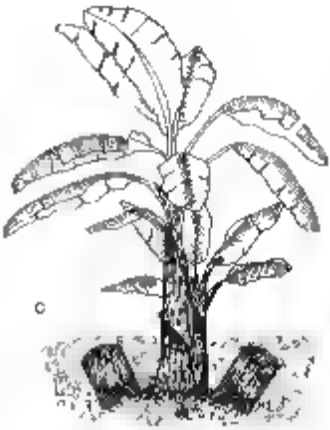
Trapping helps to keep the weevil population low, especially when done continuously while pest populations are still low in the plantation. It helps to lengthen the productive life of the plantation (Figs 15 and 16)

Harvest hygiene
The pseudostem of harvested banana should be cut down at the corm level, and soil should be placed on the cut surface to reduce weevil attraction to it. The pseudostem can then be used for traps, livestock feed or mulch (small cut and dried pieces).

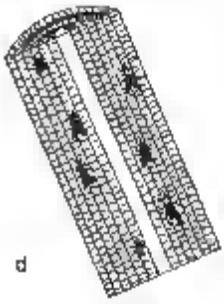
Cut the pseudostem into 12 inch sections



Then cut the 12 inch freshly cut pseudostem into equal halves from (a)



Place the split halves of pseudostem facing downwards on ground on opposite sides of the mat



Borers attached to pseudostem trap

Fig 15. The preparation of pseudostem traps and application in weevil trapping

a Disk on stump
b Leaf covering on corm

Fig 16. Weevil trapping methods

Banana Diseases and Their Management

Black sigatoka

This leaf spot disease is caused by the fungus *Mycosphaerella fijiensis*. Initially, the disease is characterised by the appearance of tiny black streaks (1–2 mm) on the underside of the leaf. The streaks then enlarge to 5–10 mm; they have no distinct border. As the disease condition advances, nearby streaks coalesce into black leaf spots that later merge to kill the entire leaf.

The disease may be propagated by planting suckers infected with the fungus. Hence, the use of clean planting material significantly reduces spread of the disease. Routine detrashing (leaf removal) and the burning of infested leaves will also decrease the incidence of the disease. Sunlight discourages the germination of the fungus spore. Cultivars resistant to the fungus are available.

While fungicides have been used successfully in commercial farms in Central and South Africa, the cost of the chemicals, which need to be repeatedly resprayed, is generally an economically prohibitive practice for the smallscale farmer.

Yellow sigatoka

This is a leaf spot disease caused by *Mycosphaerella musicola*. This disease resembles black sigatoka in all respects except the streaks in this disease are surrounded by yellow borders. The management of yellow sigatoka is similar to that of black sigatoka.

Panama disease

Panama disease or fusarium wilt is caused by the fungus, *Fusarium oxysporum* F. *cubense*, which attacks the pseudostems and corms of susceptible cultivars. *Fusarium* wilt devastated the commercial banana industry on the American continent in the early 1900s when over 100,000 acres of bananas were destroyed or abandoned. Consequently, the affected susceptible cultivar, Gros Michel, was replaced with

the popular, fusarium-resistant Cavendish variety of dessert banana. The true East African highland banana cultivars are not known to be affected by this disease

Initially, the older leaves turn bright yellow. The erect leaves collapse and hang upside-down by the pseudostem. The petioles of the older leaves may have chlorotic (bleached) streaks The inner surface of the leaf sheath displays brown flecks or spots which are diagnostic characteristics of the disease. Cross-sections of the corm and pseudostem are discolored purplish-brown. The fruit is normally not affected; otherwise the most common symptom is that leaves of the affected plant turn bright yellow, then dry up and drop around the stem. The only known method of control besides planting resistant cultivars is uprooting and burning affected plants

Bunchy top

This disease is spread by the aphid, *Pentalonia nigronervosa*. Early signs of the disease are dark green streaks in the petiole and leaf veins. Young suckers then become stunted with their leaves chlorotic (bleached) and curled. The disease may be spread locally by aphids, but long distance dispersal is primarily a consequence of transplanting infected planting materials. Except for Burundi, the disease has not yet spread through Eastern Africa. Thus, in disease-free areas, only those planting materials not affected by the virus should be used. Where the disease exists, frequent and prompt uprooting (rouging) and burning of diseased plants will reduce the incidence of disease.

Care and Harvesting of the Banana Bunch

The banana bunches undergo two phases of development.

Bunch growth

During this period of development, the fingers elongate and then increase in width, becoming less angular and more rounded. The fingers accumulate starch. Growth ceases when the fingers are mature. Depending upon the cultivar and climatic conditions, this requires about 3–4 months. The male flower (bell) should be removed when the bunch is formed and there is a gap of 6 cm that separates the bell and the terminal fruit. This promotes well-formed fingers. The female flowers can be removed to decrease the likelihood of fungal attack and rubbing of the fruit.

Bunch ripening

In this developmental phase, the fingers soften and starch is converted to sugar. The colour of the fingers changes from green to yellow as a result of a breakdown of chlorophyll, which unmasks the carotenoid yellow pigment. This stage is associated with an increased production of ethylene, a chemical which can be used artificially to induce ripening.

The bunch is harvested when it is mature—the fingers are fully formed and their angular shape rounded. There is no objective scientific method available to determine when bananas and plantains should be harvested. Since fingers have a short shelf-life after ripening, they should be picked at maturity, when they are still green. When harvested at full maturity and kept under cool conditions, the bunch can last a week before ripening is complete.

Handling and transport

Fingers consumed locally can be picked at full maturity, whereas fingers destined for market should be picked earlier to prevent peel splitting. To protect the fruit from bruising during transport, banana leaves can be used to cushion the bunch.

Conclusions

In the East African highlands, a region of perpetual food shortage, bananas are an important cash crop and staple food which can be cultivated for local consumption or for regional and global export

Once a banana crop is planted in the field, the plants are relatively easy to maintain. They undergo perennial vegetative propagation and spontaneously produce suckers After a field is established, the primary care of a banana crop involves excess sucker removal and the excision of dead or yellowing leaves. The excised suckers can be replanted and used to generate a new mat, or they may be used, along with the removed leaves, as mulch. The incidence of diseases and pests known to attack banana plants can be minimised if care is taken to transplant only disease-free and pest-free suckers